Guest Editorial Special Issue on Advanced Interface Circuits for Autonomous Smart Sensors

THE quote by Lord Kelvin, "if you can't measure it, you can't improve it," best captures the invaluable role of sensors in any system. It also implies that to improve the performance of a system one needs to employ advanced sensor solutions. The performance requirements vary from one application to another, but are always associated with accuracy, repeatability, reproducibility, range, power consumption, ease of installation, and maintenance. In the modern era of data science, machine learning, and artificial intelligence, there is an ever-increasing need for low-cost, high-performing sensors in high volumes.

Today's sensor systems have become much smarter, thanks to the advances in sensing technology and interface circuits possessing analog and/or digital signal processing capabilities. In addition, the availability of low-power wireless communication devices which can operate reliably even in highly detrimental environments, and advanced battery technologies combined with efficient power harvesting techniques, have enabled sensor nodes to achieve a high level of autonomy.

In the signal chain, extending from the sensing element to the point of data analysis and decision making, the interface circuits play a crucial role in providing the best operating mode for the sensing element, capturing the detected quantity of interest, securing a high signal-to-noise ratio in a power-efficient manner, and realizing additional functions such as self-diagnostics and auto-calibration.

It is within this context that we encouraged the sensor community to submit their latest research outcomes, to this Special Issue, in the field of advanced interface circuits for autonomous smart sensors.

We are very thankful to all authors who have contributed to this Special Issue. We received 22 excellent submissions from the Call for Papers. All papers have undergone an exhaustive review process according to the standards or the IEEE SENSORS JOURNAL. We are grateful to the reviewers for spending their valuable time giving feedback to papers, and helping us to make the final decisions about which to accept. After several rounds of revisions, 11 of the submitted papers were accepted for publication in the Special Issue.

As envisaged, the accepted papers report the latest developments in the field. These include four papers focusing on interface circuits: (i) a noise-shaping successive approximation register (SAR) analog-to-digital converter (ADC), designed with a biomedical application in mind; (ii) a negative capacitance circuit that enhances the sensitivity of a piezoelectric transducer; (iii) a digital interface that can be used to interface a wide range of resistive sensors; and (iv) a method to reduce the quantization error in a direct microcontroller interface for resistive sensors. Three papers in this Special Issue illustrate recent improvements made in the energy harvesting field: (i) a method to scavenge energy from a water column utilizing daily temperature variations, (ii) an energy harvester embedded in an oceanic drifter, and (iii) a piezoelectric harvester for smart road sensors. The remaining four papers focus on applications. One presents (i) a wireless platform for photodynamic therapy, followed by (ii) a sensing architecture for observing the balance losses during gait. The third paper discusses (iii) a new label-free biosensor, and the fourth introduces (iv) a mechanism which detects the ripening stages of pears. This is a valuable collection of the latest work on sensor interfaces and sensor system applications.

The Guest Editors would like to thank Ms. Leigh Ann Testa and Ms. Lauren Young for their kind support in the publication of this issue. We also express our gratitude to the Editor-in-Chief of the IEEE SENSORS JOURNAL, Prof. Sandro Carrara, for his suggestions, encouragement, and continuous support which has resulted in the successful publication of this Special Issue.

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Digital Object Identifier 10.1109/JSEN.2020.3027226